DOCUMENT RESUME

ED 266 958 SE 046 470

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TITLE Authentic Science: What Do Students Believe? Research Matters...To the Science Teacher.
INSTITUTION National Association for Research in Science Teaching.
PUB DATE 86
NOTE 3p.
PUB TYPE Reports - Research/Technical (143) -- Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Beliefs; Foreign Countries; Graduate Surveys; High Schools; Opinions; Science Education; *Science Instruction; *Scientific Enterprise; *Secondary School Science; *Student Attitudes; Teaching Methods
IDENTIFIERS *Canada; *Science Education Research

ABSTRACT

Science teachers have been encouraged to concentrate on teaching what science really is, rather than conveying the false and mythical images of ideal science most often found in science textbooks. With the pressure to teach "authentic" science instead of ideal science, it would be useful to know how students really think about sciences. A study was recently completed with a stratified sample of 10,800 graduating high school students across Canada, and selected findings from this study are presented. Also presented are 20 statements which teachers can use to investigate what their students believe about the scientific enterprise by requiring that students take a position on each statement and justify their views). (JN)

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Research Matters... To the Science Teacher

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AUTHENTIC SCIENCE: WHAT DO STUDENTS BELIEVE?

By Glen S. Aikenhead

Science teachers have been encouraged to concentrate on teaching what science really is, rather than conveying the false and mythical images of ideal science most often found in science textbooks. (See, for example, the 1985 NSTA Yearbook, *Science-Technology-Society*.) With the pressure to teach authentic science instead of ideal science, it would be useful to discover what the graduates of the present science curriculum have generally learned about science. This summary also offers guidelines for finding out what your students believe about the scientific enterprise.

Information about how to teach and evaluate such content may be found in another *Research Matters publication*, "Teaching Authentic Science."

Student Beliefs

Many studies have assessed what beliefs and understandings students have about the scientific enterprise. Very illuminating results are obtained when students are asked to write a short paragraph explaining their views. Such a study was recently completed with a stratified sample of 10,800 graduating high school students across Canada. Each student was asked to respond to a statement concerning the nature of the scientific enterprise (see the sample statements below) by checking "agree," "disagree" or "can't tell," and writing a short paragraph explaining the reasons for the choice. The statements dealt with (a) the interactions among science, technology and society, (b) the characteristics of scientific knowledge, and (c) the characteristics of scientists. These student paragraphs yielded common arguments or beliefs on a number of topics. Some of the findings are listed here.

- Unless specifically asked to do so, students did not distinguish between science and technology, but used an all-inclusive "technoscience" concept when writing about the scientific enterprise. (Students tended to equate scientific research with medical research, and to a lesser degree, environmental and agriculture research.)
- Students viewed science to be closely interrelated with society in a number of ways:
  1. Scientists are, and should be, concerned with the harmful and beneficial effects of their work.
  2. Social interactions (eg. tennis, parties and conferences) affect what scientific knowledge is discovered.
  3. The political climate of a country will affect scientists especially through government funding.
- Scientific classification schemes were generally perceived to be man made, though fewer students felt the same way about scientific models.
- Most students believed that scientific knowledge was tentative but did so for different and conflicting reasons (eg. old knowledge is reinterpreted in light of new ideas, old knowledge was in error, and old knowledge was "added to," thereby giving a different picture).
- "The scientific method" was perceived differently by each student. Almost no one referred to the five or seven step method portrayed in textbooks. Many students believed that "the scientific method" entailed meticulously and rigidly following prescribed lab procedures. Is this perhaps a result of doing high school labs in a similar manner?
- Students expressed confidence in scientists and engineers deciding science-related social issues; ie. faith in a technocratic rather than a democratic approach.
- Confidence was also expressed in more women becoming scientists or engineers. A majority of students, male and female equally, believed that traditional social conditions responsible for less women being in science had subsided in their generation.
- Few gender differences surfaced, except that females tended to believe more in creative, non-rigid thinking as an attribute of good scientists, while males tended to believe more in the objectivity and social isolation of science.

Getting Started On Your Own

You can investigate what your own students believe about the scientific enterprise.

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- Present your students with a statement or situation. Examples are given below. Make up your own statements to suit the topics of interest to you and your students.
- Get your students to state whether they agree, disagree or can't tell with the statement or situation. This forces them to take a position on the issue.
- Ask your students to write the reasons for their view (usually two to five sentences in length).

Sample Statements

The following examples are taken from the inventories used to gather the Canadian data.

1. Scientists and engineers should be given the authority to decide what types of energy this country will use in the future because scientists and engineers are the people who know the facts best.
2. Scientists should be held responsible for reporting their findings to the general public in a manner that the average person can understand.
3. Science and technology offer a great deal of help in resolving such problems as poverty, crime, unemployment, overpopulation and the threat of nuclear war.
4. The government should give scientists research money to explore the unknowns of nature and the universe.
5. Communities or government agencies should tell scientists what problems to investigate; otherwise scientists will investigate only what is of interest to them and not necessarily investigate the problems of interest to communities or government agencies.
6. The political climate of a country affects its scientists because they are an integral part of society.
7. In order to improve the quality of living in this country, it would be better to invest money in technological research rather than scientific research.
8. Many scientific models (such as a model of the atom or of DNA) are metaphors or useful stories; we should not believe that these models are duplicates of reality.
9. When scientists classify something (eg. a plant according to its species, an element according to the periodic table, or energy according to its source), scientists are classifying nature according to the way nature really is; any other way would simply be wrong.
10. When scientific investigations are done correctly, scientists discover knowledge that will not change in future years.
11. The best scientists are those who follow the steps of the scientific method.
12. A scientist may play tennis, go to parties, or attend conferences with other people. Because these social contacts can influence the scientist's work, these social contacts can influence the content of the scientific knowledge he or she discovers.
13. When scientists disagree on an issue (eg. whether or not low-level radiation is harmful), they disagree mostly because of their different personal motives (eg. pleasing their employers or wanting research grants from the government).
14. When scientists disagree on an issue (eg. whether or not low level radiation is harmful), they disagree mostly because one side does not have all the facts.
15. Earning recognition from other scientists is really the main motivation of most scientists.
16. Most scientists are concerned with the potential effects (both helpful and harmful) that might result from their discoveries.
17. Scientists should be held responsible for harm that might result from their discoveries.
18. Scientists are likely to be unbiased and objective, not only in their research work, but in other areas of their life as well.
19. There are no justifiable reasons why so many scientists are male, rather than there being an equal proportion of male and female scientists.
20. The qualities of honesty and objectivity, commonly associated with a scientific report, are largely due to the fact that other scientists might try to verify the report and could find embarrassing errors. Scientists as a group are no more honest and objective than any other group of people.

The National Association For Research in Science Teaching is an organization that seeks to improve science teaching through research. For further information, contact the NARST Executive Secretary:

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